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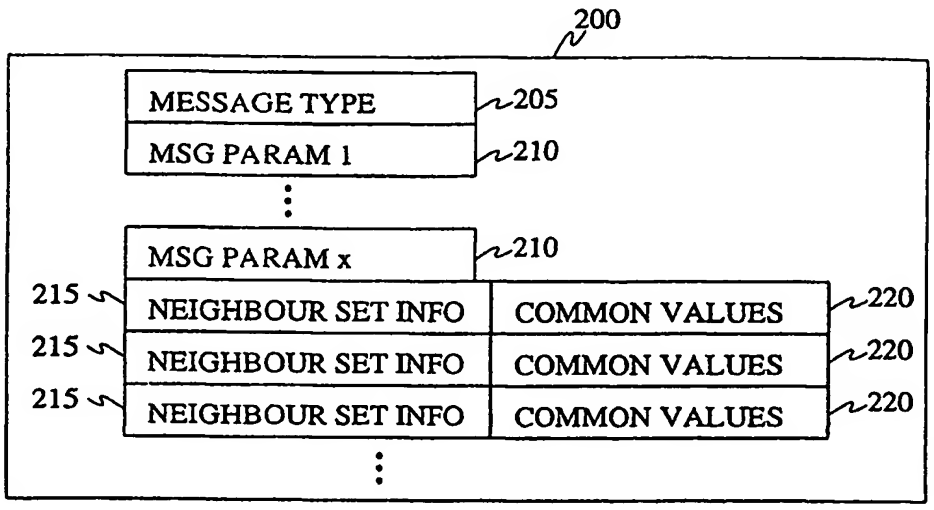

(57) Abstract

The invention is related to signaling in cellular telecommunication systems, namely to reduction of resources used by signaling. According to the invention, a list of neighbor cell information is communicated to a mobile station in compressed form. Preferably, the neighbor cell information list is transmitted in such a way, that a table reciting parameter values in use by the neighboring cells, and for each of these cells, each value listed in the table is represented by a pointer such as an index to the table. In this way, same parameter values do not need to be repeated for each cell using the same values. The neighbor cell information list can be further compressed by expressing a first frequency parameter value in the normal way, but expressing further frequency parameter values relative to the first, or as in a further embodiment, relative to the previous frequency parameter value. Such ways of representing frequency values allow the use of fewer bits to represent the frequency values.

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A method for communication of neighbor cell information

TECHNICAL FIELD OF THE INVENTION

The invention is related to signaling in cellular telecommunication systems, namely to reduction of resources used by signaling. Particularly, the invention is directed to a method according to the preamble of claim 1.

BACKGROUND OF THE INVENTION

In the present GSM (Global System for Mobile communications) system, the network informs from time to time each mobile station about the base stations nearby the mobile station. The network performs this informing by sending a so called neighbor list to the mobile station, which neighbor list recites the basic parameters of the neighboring cells, such as the base station identity code (BSIC) of the base stations of the cells, the BCCH (Broadcast Control Channel) frequency, and several other parameters.

Figure 1 illustrates a part of the structure of a GSM network. Figure 1 shows a mobile station (MS) 10, base stations (BS) 20, and base station controllers (BSC) 30. For clarity, areas of the cells corresponding to the base stations and other network elements of a GSM network are not illustrated in figure 1. The neighboring cells are simply the cells lying nearby the mobile station. One possible selection of neighboring cells is marked with a rectangle 25 in figure 1.

The network 20, 30 informs the mobile station 10 about the neighboring cells in a message, which recites the cell parameters for each neighboring cell. The resulting message may be long, if the number of neighboring cells is large. According to the present GSM specifications, the maximum number of cells reported in a neighbor cell information message is 16. Due to the length of the message, the transmission time required to transmit the message is long, which results in a relatively large usage of signaling channel capacity for only this purpose. Also, during the transmission of the message the receiver of the mobile station receiving the message has to receive the message, whereby the length of the message affects considerably the receiving capacity of the mobile station. The length of the message also makes it impractical to increase the number of cells described in a neighbor cell information message, which would be advantageous especially in those locations of the network,

in which a large number of cells are available to a mobile station or may become available to the mobile station due to movement of the mobile station. If the repetition frequency of sending the message would be decreased, the length of the message could be increased, but in that case, the mobile stations would receive the message less often, which could cause other difficulties. These problems are presently increasing in severity due to the present trend in the cellular telecommunication systems towards decreasing the area of cells due to increasing data rates, whereby the increasing of the number of cells described in a neighbor cell information message is desired. This trend is driven by the development of high data rate services and packet data services, such as the GPRS (General Packet Radio Service) system.

The transmitted parameters and structure of a neighbor cell information message is described in more detail in the GSM 04.08 specification.

SUMMARY OF THE INVENTION

An object of the invention is to realize a method which allows shortening the time required for the communication of a neighbor cell information message. An object of the invention is also to realize a method of communicating neighbor cell information reserving the receiver of a mobile station for a shorter time than in the prior art. A further object of the invention is to save the transmission capacity of signaling channels used for transmitting neighbor cell information messages.

The objects are reached by identifying redundant information in the neighbor cell information message, and removing at least a part of the redundancy by specifying the repeating values of at least one parameter only once.

The method according to the invention is characterized by that, which is specified in the characterizing part of the independent method claim. The system according to the invention is characterized by that, which is specified in the characterizing part of the independent claim directed to a system. The network element according to the invention is characterized by that, which is specified in the characterizing part of the independent claim directed to a network element. The mobile communication means according to the invention is characterized by that, which is specified in the characterizing part of the independent claim directed to a mobile communication means. The dependent claims describe further advantageous embodiments of the invention.

According to the invention, a list of neighbor cell information is communicated to a mobile station in compressed form. Preferably, the neighbor cell information list is transmitted in such a way, that a table reciting parameter values in use by the neighboring cells, and for each of these cells, each value listed in the table is represented by a pointer such as an index to the table. In this way, same parameter values do not need to be repeated for each cell using the same values. The neighbor cell information list can be further compressed by expressing a first frequency parameter value in the normal way, but expressing further frequency parameter values relative to the first, or as in a further embodiment, relative to the previous frequency parameter value. Such ways of representing frequency values allow the use of fewer bits to represent the frequency values.

The inventive method of constructing a neighbor cell information message is advantageous, since the inventors have made the insightful observation, that neighboring base stations quite commonly have largely similar operation parameters, which results in the repeating of same parameter values for a plurality of cells in a neighbor cell information message. The length of a neighbor cell information message, and time and transmission capacity required for sending such a message can be considerably shortened by removing at least some of the redundancy of information in the neighbor cell information message by specifying at least some repetitive values only once, and replacing the occurrences of the value with a pointer to the single specification of the value. The inventive method of constructing a neighbor cell information message also allows the describing of more cells in a neighbor cell information message than in prior art, since the compressed message format allows the increasing of the number of base station described in the message without unduly increasing the length of the message.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is described in more detail in the following with reference to the accompanying drawings, of which

figure 1 illustrates the structure of a cellular telecommunication network and the concept of neighbor cells,

figure 2 illustrates the structure of a message for transmitting neighbor cell list information according to an advantageous embodiment of the invention,

figures 3 and 4 illustrate the structure of two fields in the message illustrated in figure 2,

figure 5 illustrates the structure of a field shown in figure 3,

figure 6 illustrates a system according to an advantageous embodiment of the invention, and

figure 7 illustrates a mobile communication means according to an advantageous embodiment of the invention.

Same reference numerals are used for similar entities in the figures.

DETAILED DESCRIPTION

A. COMPRESSION OF NEIGHBOR CELL INFORMATION LIST

According to the invention, the neighbor cell information is transmitted to mobile stations in compressed form by reducing the amount of redundant information transmitted.

In an advantageous embodiment of the invention, those pieces of information which are repeated for a plurality of cells in the neighbor cell information list are recited in a table or some other suitable data structure, and pointers such as indexes to the table are used in the places of pieces of redundant information.

In an advantageous embodiment, such a table contains different values for one parameter. For example, if a certain parameter value is used in more than one cells, values of the particular parameter used in the neighboring cells are placed in a table, and references to a value of this parameter are replaced by a pointer such as an index to the table, which pointer specifies which of the entries in the table is to be used. Such a table is created for each parameter, which has at least one value repeating in more than one cell.

In a further embodiments of the invention, groups of parameters can be stored in a table. Such an embodiment is advantageous, if certain parameter value combinations are repeated in a plurality of cells in the neighboring cells.

B. SPECIFICATION OF FREQUENCY VALUES

In an advantageous embodiment of the invention, the transmission capacity required for the transmission of a neighboring cell information list is further reduced by specifying a plurality of frequency values in a relative way, instead of reciting each value in full.

In a first example, the frequency values can be specified by specifying a first frequency value F_0 in full, and subsequent frequency values relative to the first frequency value, i.e. by specifying the difference Δf_n of the frequency value F_n to the first frequency value F_0. Subsequently, the actual frequency values can be obtained by adding the difference to the first frequency value, i.e. $F_1 = F_0 + \Delta f_1$, $F_2 = F_0 + \Delta f_2$, and so on. This method of specifying the frequency values is advantageous, when the specified frequency values are not far apart, since in that case, a small number of bits is enough to represent the difference values.

In a second example, the frequency values can be specified by specifying a first frequency value F_0, and for subsequent frequency values, the difference to the previous frequency value. Subsequently, the actual frequency values can be obtained in the following way:

$$F_1 = F_0 + \Delta f_1$$
$$F_2 = F_1 + \Delta f_2 = F_0 + \Delta f_1 + \Delta f_2$$
$$F_3 = F_2 + \Delta f_3 = F_0 + \Delta f_1 + \Delta f_2 + \Delta f_3$$

and so on. This second example of a way of specifying frequency values performs better than the first when the frequency values cover a relatively wide range, since the cumulative calculation principle still allows the representation of the frequency value differences with a small number of bits.

In an advantageous embodiment of the invention, either of the first and the second examples ways of specifying frequency values can be used. Advantageously, the frequency value specification method is chosen based on the distribution of frequencies to be specified, i.e. based on which of the two methods allows representation of the frequency data in a smaller amount of bits.

C. AN EXAMPLE OF A COMPRESSED FORMAT

Figures 2, 3, 4, and 5 illustrate a method of communicating a neighboring cell information list according to an advantageous embodiment of the invention. These figures illustrate the structure of a message used to communicate neighboring cell information from the network to a mobile station.

Figure 2 illustrates the general structure of a neighboring cell information message 200. The message 200 comprises a plurality of fields. The first field 205 is a message type field, which is used to indicate the message type, in this case that the message is a neighboring cell information message. Following this field, there may be zero, one, or more 210 fields which are specific to a single message. These fields may contain message-specific parameters, for example. The message further comprises one or more pairs of NEIGHBOR SET INFO 215 and COMMON VALUES 220 fields. Both of these fields contain a structure of fields, which structures are described further with reference to figures 3, 4, and 5. In this specification, the term neighbor set refers to a set of neighbor cells. A neighbor cell set may cover all neighbor cells, or only some of them. The concept of a neighbor set is used for convenience: it is advantageous to group neighbor cells with similar parameters into one or more groups in order to specify the neighbor cell information in a minimum amount of bits. These groups are referred to as neighbor sets in this specification.

Figure 3 illustrates an example of the structure of a NEIGHBOR SET INFO field 215, which specifies the information of the cells in a single neighbor set. The field comprises a STARTING FREQ field 230, which specifies the frequency F_0 described previously, i.e. the BCCH frequency of the first cell of the current neighbor set. The next field 235 specifies the number M of cells in the current neighbor set. The FREQ DIFF LENGTH field 240 specifies the number of bits used to specify the frequency differences Δf_n , and the FREQ DIFF TYPE field 245 specifies, which of the available methods for specifying frequencies is used. The frequencies can be specified for example using either of the methods specified previously in section B of this specification. Further, it is also possible to specify the frequencies in the normal way, i.e. by specifying the frequencies in full in the same way as the frequency F_0, in which case the FREQ DIFF LENGTH field 240 should specify the number of bits needed to store a frequency value, and the FREQ DIFF TYPE field 245 should contain a predetermined value indicating that the frequency values are normal values, i.e. not relative values. After these fields, the

NEIGHBOR SET INFO field 215 comprises M pairs of fields 250, 255, each pair specifying the information of a single cell. The first field of the field pair, namely the FREQ DIFF x field 250 specifies the BCCH frequency of the cell in the way specified in the FREQ DIFF TYPE field 245. The CELL x INFO field 255 recites the rest of the cell information of the particular cell. The CELL x INFO field 255 is also a structured field comprising a plurality of fields. The structure of the CELL x INFO field 255 is described later in this specification with reference to figure 5.

Figure 4 illustrates the structure of a COMMON VALUES field 220. The field comprises PARAMETER x VALUE LIST fields 222, each reciting those values of a certain parameter which values are used in the cells of the current neighbor set. There may be N such fields in a COMMON VALUES field 220, the number N being any integer equal to or larger than one. The invention is not limited to using any specific particular data structure such as a list structure in a PARAMETER x VALUE LIST, since a set of values can be stored in many different ways using many different data structures.

Figure 5 illustrates the structure of a CELL x INFO field 255. This field specifies the information concerning a single neighbor cell. The CELL x INFO field 255 comprises a BSIC field 256, which specifies the BSIC (base station identity code) of the cell. In addition to the BSIC field 256, the CELL x INFO field 255 may comprise also other fields which always contain cell specific information. The CELL x INFO field 255 also comprises PARAMETER x POINTER fields 257, each of which contains a pointer specifying which of the values of the corresponding PARAMETER x VALUE LIST field 222 is to be used for the particular cell being described by the CELL x INFO field 255.

The length of the PARAMETER x POINTER fields can be always the same, such as 4 bits, which would allow representation of 16 different values, which is the maximum number of neighbor cells in the neighbor cell list according to current GSM 04.08 specification. However, the network often informs the MS about less than 16 neighbor cells, and often the cells do not have many different values of the same parameters. Therefore, three or even two bits would often be enough, allowing respectively the specification of eight or four parameter values. To shorten a neighbor cell information message even further, the length of the PARAMETER x POINTER fields can be made variable. In such an embodiment, the CELL x INFO field preferably comprises for example a three-bit field before the PARAMETER x

POINTER fields, which three-bit field specifies the length of the PARAMETER x POINTER fields 257 in the current CELL x INFO field 255.

As described previously, a PARAMETER x POINTER field can indicate the value of a single parameter. However, in a further advantageous embodiment of the invention, the COMMON VALUES field comprises one or more sets of parameter combinations, which parameter combinations are referred to using pointers or some other ways of indicating an element of a set. One parameter value combination can specify the values of two or more parameters. Such an embodiment is advantageous in cases, when certain parameter value combinations are common in the neighbor cells, and allows further reduction of the size of neighbor cell information message.

The message structure illustrated in figures 2, 3, 4, and 5 is only an example of an advantageous embodiment of the invention, and does not limit the invention in any way.

D. AN EXAMPLE OF A SYSTEM

In the following, a system according to an advantageous embodiment of the invention will be described with reference to figure 6. Figure 6 illustrates a part of a cellular telecommunication system, namely a base station controller (BSC) 30 and two base stations 20. A mobile station 10 is also illustrated. According to the invention, the BSC comprises a system 300 for generating a neighbor cell information message specifying values of a plurality of values of a plurality of parameters for at least one neighbor cell. The system 300 comprises

- means 310 for identifying parameter values in use by more than one cell,
- means 320 for outputting a set of said identified values, and
- means 330 for indicating the value of a parameter, which means for indicating is arranged to output the value of the parameter when the value is not one of said identified values, and to output information specifying an element of said set, when the value is one of said identified values.

Preferably the means 310, 320, and 330 are realized using software programs stored in a memory element of a control unit of the network element such as a BSC, the programs being executed by a microprocessor of the control unit.

The inventive system can advantageously be implemented in a base station controller (BSC). However, the invention is not limited to implementation in a BSC, since the system can also be implemented in other network elements.

E. AN EXAMPLE OF A MOBILE COMMUNICATION MEANS

In figure 7, a block diagram of a mobile station 10, or generally a mobile communication means 10 according to a further advantageous embodiment of the invention is shown. The receiver part of the mobile communication means comprises a first receiver filter 452 for filtering the received signal, a receiver amplifier 454 for amplifying the received signal, a second receiver filter bank 456 for further filtering of the received signal, a mixer 458 for converting the received signal to baseband, a receiver block 460 for demodulating and decoding the signal and an earpiece 462 or a loudspeaker 462 for producing the audible received signal. The transmitter part comprises a microphone 472, a transmitter block 474 for coding the signal to be transmitted and performing other necessary signal processing, a modulator 476 for producing the modulated radio frequency signal, a first transmitter filter 478, a transmitter amplifier 480, and a second transmitter filter 482. The mobile communication means further comprises an antenna 498, an oscillator block 496, a control block 490, a display 492 and a keypad 494. The control block 490 controls the functioning of the receiver and transmitter blocks and the oscillator block, as well as displays information to the user via the display 492 and receives commands from the user via the keypad 494.

According to the invention, a mobile communication means 10 further comprises at least

a) means 410 for receiving a neighbor cell information message comprising a set of parameter values, and for each cell of a plurality of neighbor cells, cell information comprising

- at least one parameter value for a first parameter, and
- for at least one second parameter, one second value indicating which value of said set of parameter values is used for said second parameter,

b) means 420 for associating a value of said set of parameter values indicated by one of said second values with the corresponding parameter of a neighbor cell.

Said first parameter can be for example the base station identity code BSIC.

Preferably the means 410 and 420 are realized using software programs stored in a memory element of a control block 490 of the mobile communication means 10, the programs being executed by a microprocessor of the control block 490.

A mobile communication means can be any mobile unit or a mobile station capable of communicating through the radio interface of a cellular telecommunications network such as a GPRS or a UMTS network. Examples of such mobile communication means are a cellular telephone, a video telephone, and a GPRS data terminal.

F. FURTHER CONSIDERATIONS

The inventive method has the advantage, that the same pieces of information i.e. parameter values are not repeated many times in one neighbor cell information message. This saves transmission capacity of the signaling channel, and shortens the time required for sending a single message, which in turn allows the receivers of the mobile stations to use more time to other duties.

The invention can be applied in any cellular telecommunication system, in which the network transmits neighbor cell information to mobile stations. Examples of such systems are the GSM system and the UMTS (Universal Mobile Telecommunication System) system, which may comprise packet data transmission systems such as the GPRS system.

The name of a given functional entity, such as the radio network controller, is often different in the context of different cellular telecommunication systems. For example, in the GSM system the functional entity corresponding to a radio network (RNC) is the base station controller (BSC). Therefore, the term radio network controller in the claims is intended to cover all corresponding functional entities regardless of the term used for the entity in the particular cellular telecommunication system. Further, the various command and field names such as the NEIGHBOR SET INFO field name are intended to be examples only, and the invention is not limited to using the command and field names recited in this specification.

In this specification and particularly in the following claims, the term frequency value means an indication of a frequency in some predefined way. The invention is not limited to any specific way of expressing a frequency, since a frequency can be

expressed in many ways, for example in units of hertz (Hz), or for example by using a predefined channel numbering scheme, in which case a channel number corresponds to a certain frequency. Consequently, a channel number or some other channel identification value can be used as a frequency value.

The parameters, whose values are specified in a neighbor cell information message, can be any cell parameters which the mobile station needs to know when communicating with a particular cell. Such parameters can comprise for example the BCCH channel frequency of a cell, a spread spectrum code such as the code used in the pilot signal of a particular cell in spread spectrum based cellular systems, or for example packet transmission parameters of a packet data transmission system such as the GPRS system. The invention is not limited to any particular selection of parameters to be recited in a neighbor cell information message.

The term set in the following claims is not intended to limit the invention to using any specific data structure for storing a number of parameter values, since a set of values can be stored in many different ways using many different data structures as known by a person skilled in the art.

In view of the foregoing description it will be evident to a person skilled in the art that various modifications may be made within the scope of the invention. While a preferred embodiment of the invention has been described in detail, it should be apparent that many modifications and variations thereto are possible, all of which fall within the true spirit and scope of the invention.

Claims

1. A method for communicating information about neighboring base stations to a mobile station in a cellular telecommunication network, **characterized** in that a message specifying the information is compressed by decreasing the redundancy of information in the message.

2. A method according to claim 1, **characterized** in that the method comprises steps, in which a set of parameter values is communicated to the mobile station, and for each of a plurality of base stations, the value of at least one parameter is indicated by specifying an element of said set.

3. A method according to claim 1, **characterized** in that the method comprises steps, in which a set of parameter value combinations is communicated to the mobile station, and for each of a plurality of base stations, the value combination of at least two parameters is indicated by specifying an element of said set.

4. A method according to claim 2, **characterized** in that the neighbor cells of a mobile station are grouped into more than one neighbor sets, and for each neighbor set, said set of parameter values is generated from parameters of the neighbor set.

5. A method according to claim 1, **characterized** in that a plurality of frequency values is specified by specifying a first frequency value in full and further frequency values relative to said first frequency value.

6. A method according to claim 1, **characterized** in that a plurality of frequency values is specified by specifying a first frequency value in full and further frequency values relative to the previously specified frequency value.

7. A method according to claim 1, **characterized** in that the method is used in a UMTS network.

8. A method according to claim 1, **characterized** in that the method is used in a GPRS network.

9. A system in a cellular telecommunication network for generating a neighbor cell information message specifying values of a plurality of values of a plurality of

parameters for at least one neighbor cell, **characterized** in that the system comprises

- means for identifying parameter values in use by more than one cell,
- means for outputting a set of said identified values, and
- means for indicating the value of a parameter, which means for indicating is arranged to output the value of the parameter when the value is not one of said identified values, and to output information specifying an element of said set, when the value is one of said identified values.

10. A network element of a cellular telecommunication network comprising a system for generating a neighbor cell information message specifying values of a plurality of values of a plurality of parameters for at least one neighbor cell, **characterized** in that

the system comprises

- means for identifying parameter values in use by more than one cell,
- means for outputting a set of said identified values, and
- means for indicating the value of a parameter, which means for indicating is arranged to output the value of the parameter when the value is not one of said identified values, and to output information specifying an element of said set, when the value is one of said identified values.

11. A mobile communication means for communication with a cellular telecommunication network, **characterized** in that the mobile communication means comprises at least

a) means for receiving a neighbor cell information message comprising
a set of parameter values, and for each cell of a plurality of neighbor cells,
cell information comprising

- at least one parameter value for a first parameter, and
- for at least one second parameter, one second value indicating which value of said set of parameter values is used for said second parameter,

b) means for associating a value of said set of parameter values indicated by one of said second values with the corresponding parameter of a neighbor cell.

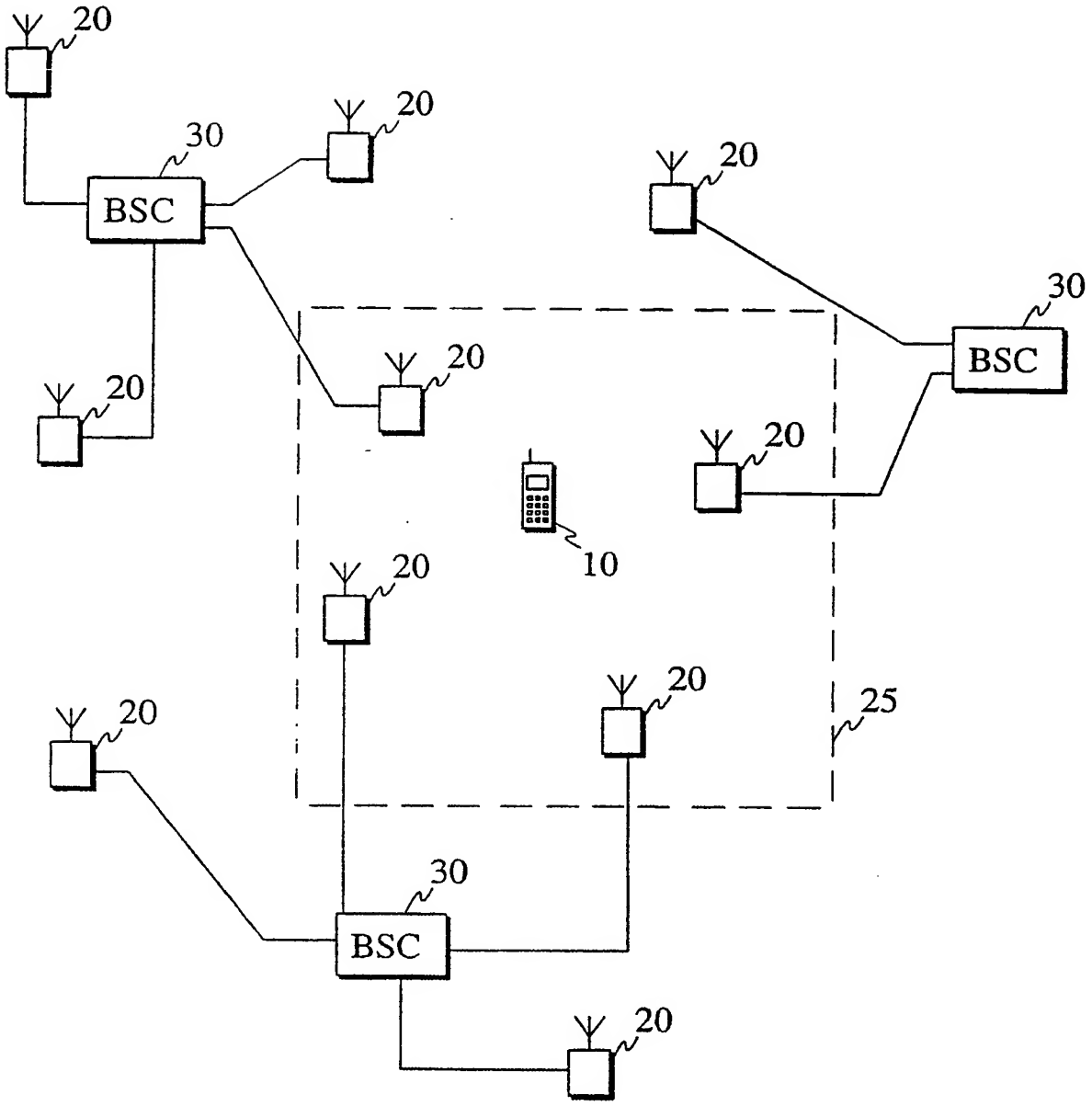

Fig. 1

PRIOR ART

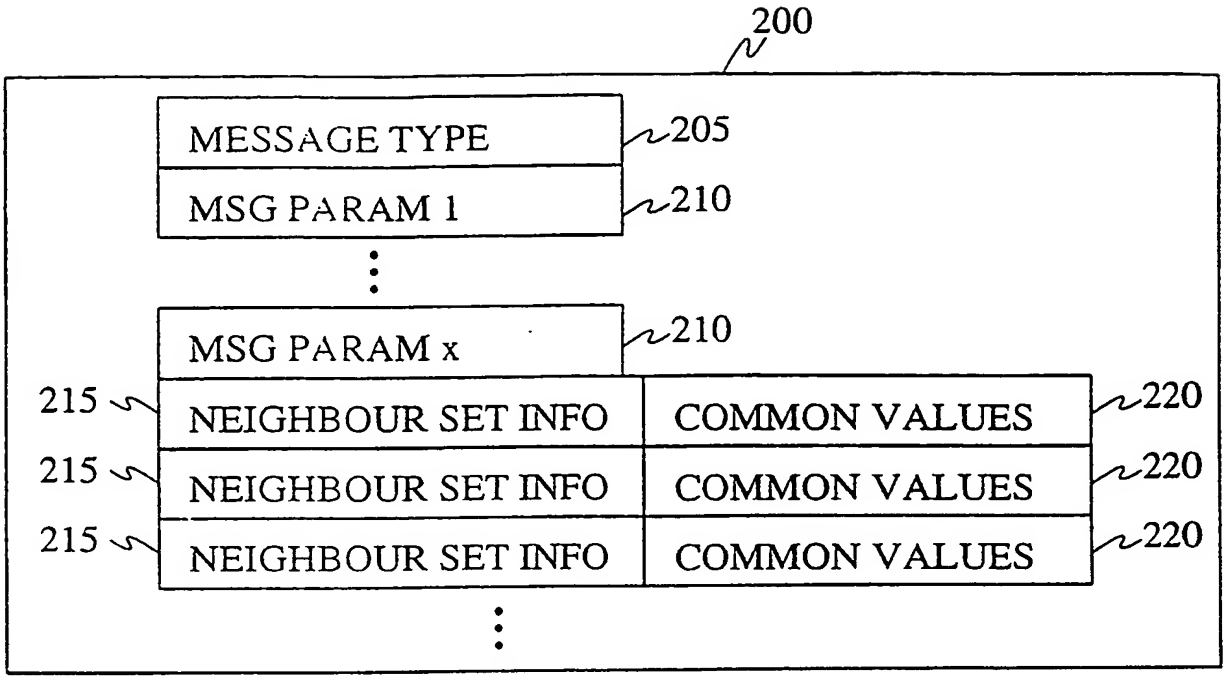

Fig. 2

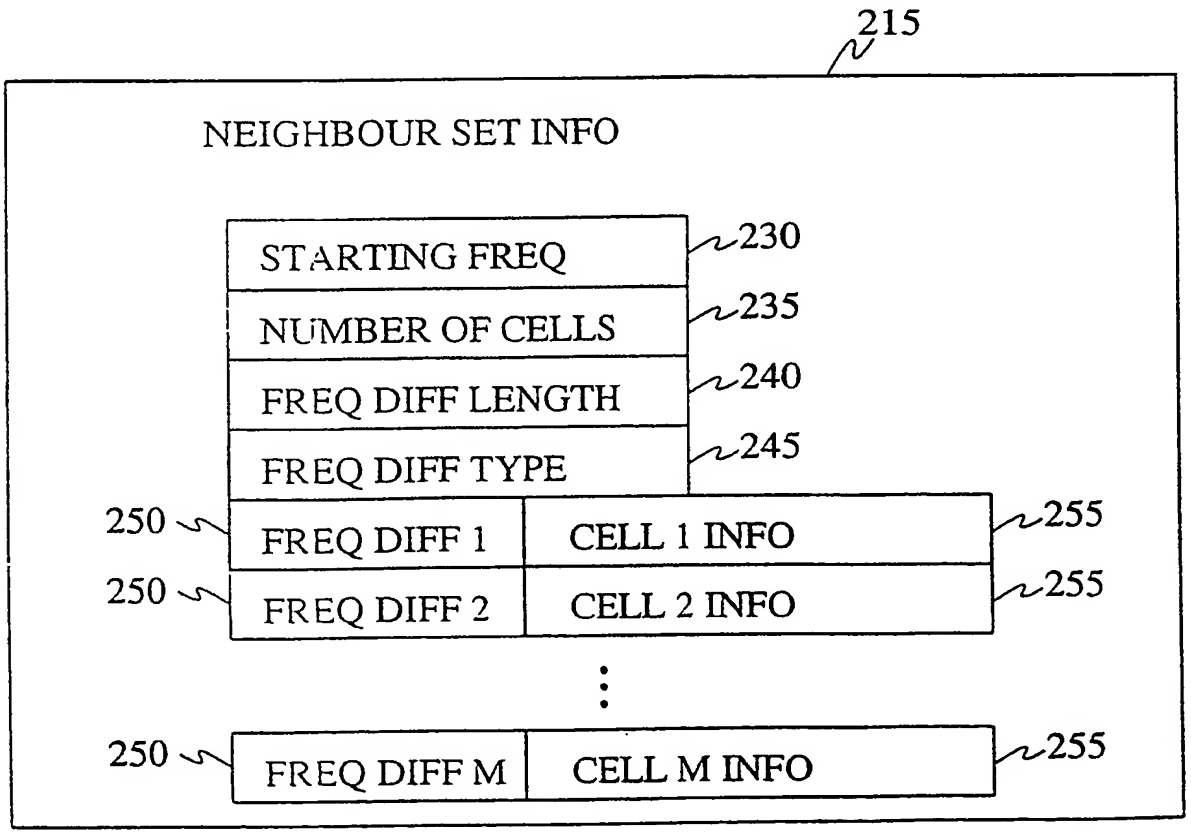

Fig. 3

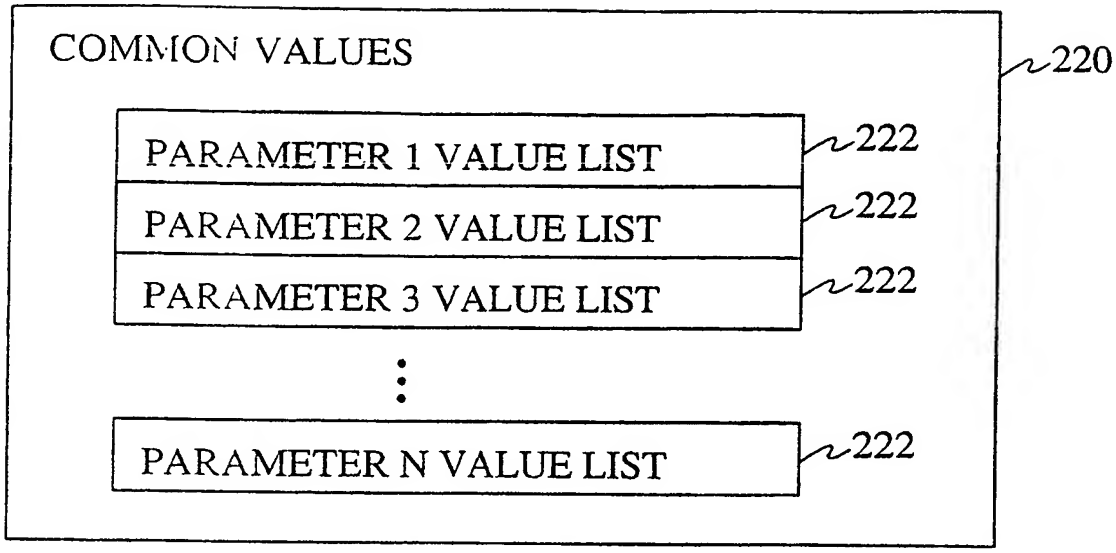

Fig. 4

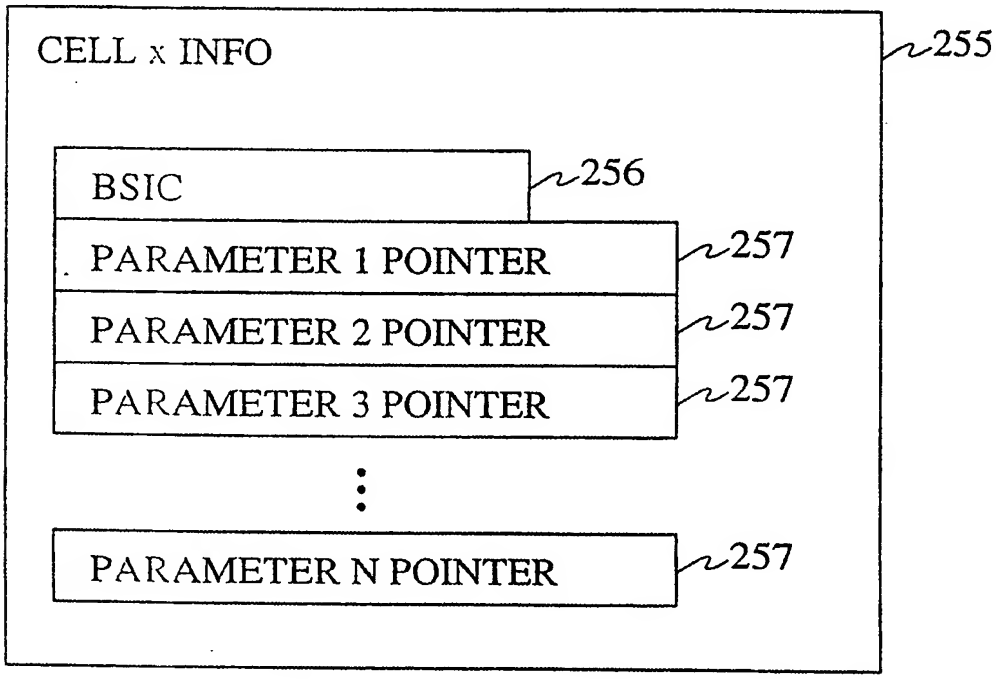

Fig. 5

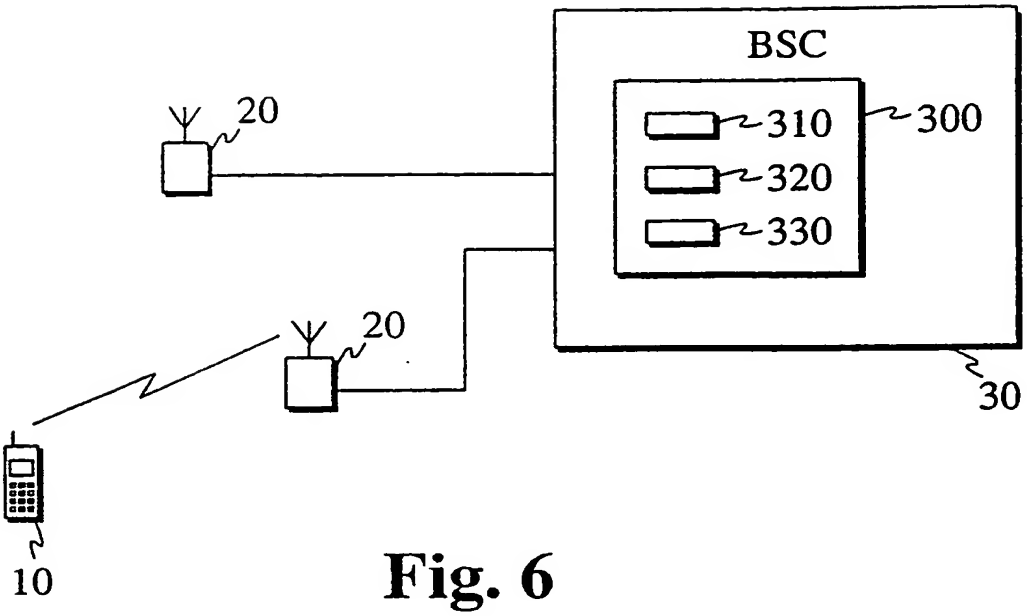

Fig. 6

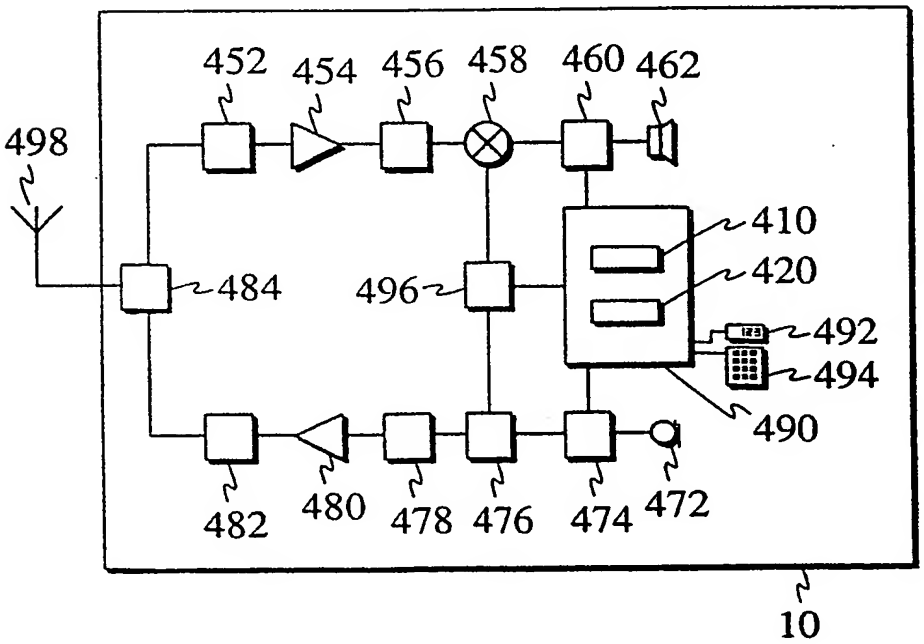

Fig. 7

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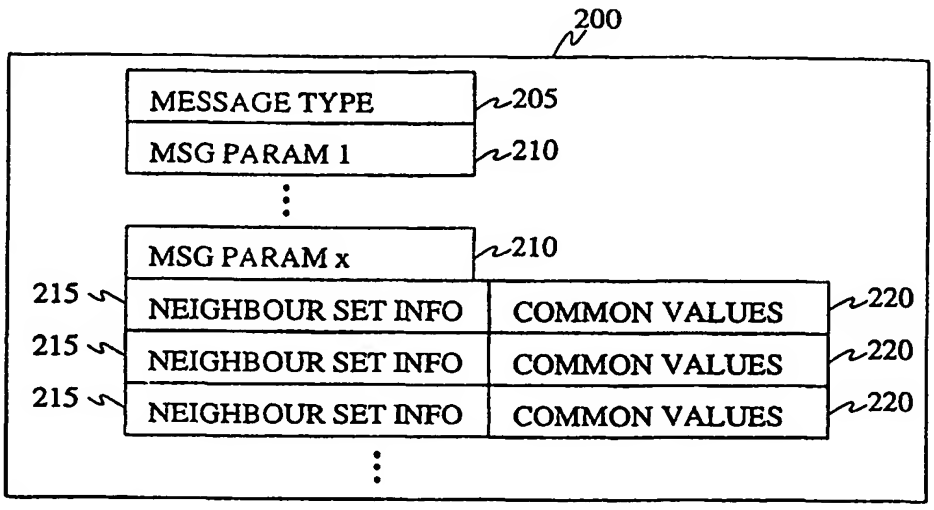

(57) Abstract

The invention is related to signaling in cellular telecommunication systems, namely to reduction of resources used by signaling. According to the invention, a list of neighbor cell information is communicated to a mobile station in compressed form. Preferably, the neighbor cell information list is transmitted in such a way, that a table reciting parameter values in use by the neighboring cells, and for each of these cells, each value listed in the table is represented by a pointer such as an index to the table. In this way, same parameter values do not need to be repeated for each cell using the same values. The neighbor cell information list can be further compressed by expressing a first frequency parameter value in the normal way, but expressing further frequency parameter values relative to the first, or as in a further embodiment, relative to the previous frequency parameter value. Such ways of representing frequency values allow the use of fewer bits to represent the frequency values.

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INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER

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B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

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Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

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P,X	WO 9913666 A1 (TELEFONAKTIEBOLAGET LM ERICSSON), 18 March 1999 (18.03.99), abstract --	1
P,X	WO 9917571 A1 (TELEFONAKTIEBOLAGET LM ERICSSON), 8 April 1999 (08.04.99), page 4, line 6 - line 22, abstract	1
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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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P,A	EP 0895435 A1 (HEWLETT-PACKARD COMPANY), 3 February 1999 (03.02.99), claim 1 --	1-14
A	WO 9853621 A2 (QUALCOMM INCORPORATED), 26 November 1998 (26.11.98), page 9, line 3 - line 15 --	1-14
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Information on patent family members

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